August, distance 0·891 ; No. 80, *Sappho*, in September, distance 0·847 ; and No. 27, *Euterpe*, in December, distance 0·980. No. 157, *Dejanira*, comes into opposition and aphelion about the same time, and the magnitude descends to 15·7. The last of the minors discovered is in opposition in December, mag. 14·6, but No. 216, also a recent discovery, is as bright as 8·4 at opposition on October 7. There is perhaps not much hope of recovering *Medusa* (which from the best orbit obtainable from the short course of observation in 1879 would appear to have the least mean distance amongst the small planets) in the present year, the magnitude being only 13·5, and the computed places necessarily liable to considerable error. Nos. 205, 207, 208, 210, 212, 216, 218, 219, and 220 are still without names.

MR. W. R. BIRT.—Mr. Birt, so well known in connection with lunar work, died at Leytonstone on December 14 in his seventy-eighth year. He had occupied himself some fifty years since with the variable stars, and announced in 1831 the variability of α Cassiopeiæ, a difficult case, for the fluctuation in its light would appear not to exceed a half-magnitude, and indeed has been doubted by no less an authority than Prof. Julius Schmidt. Sir John Herschel, however, supported Mr. Birt's conclusion, and we were once shown by the late Prof. Heis a series of curves exhibiting the results of several years' observations, which indicated sensible though very irregular variability. Much of Mr. Birt's lunar work was undertaken under the auspices of a Committee of the British Association, and his maps of various parts of the moon's surface, extending to great detail, are well known.

M. ALFRED GAUTIER.—In the death of M. Alfred Gautier, at Geneva, on November 30, at the age of eighty-eight years, as already announced, the Royal Astronomical Society have lost the oldest Associate upon their list ; he died in full possession of his faculties after a very short illness. M. Gautier was elected into the above Society in January, 1822, or two years after its formation. M. Plantamour of Geneva now heads the list of Associates.

THE SMOKE ABATEMENT EXHIBITION

THIS Exhibition originated, as explained in the introduction to the Catalogue, in the action of the Committee of the National Health Society, with whom the Kyrle Society afterwards joined in appointing a Joint Committee to consider how action could be taken which should tend to the abatement of the smoke produced in the metropolis. In the words of this introduction, "The first proceeding of the Committee was to communicate with colliery owners and manufacturers of heating apparatus as to the means available for the reduction of smoke, and next with the metropolitan parochial authorities and public bodies, directing their attention to the serious and increasing evil, and asking their co-operation in abating it." Public meetings were held at the Mansion House and other places in different parts of London ; and the public interest in the subject appearing to be sufficient to justify such an experiment, the Committee determined to hold an exhibition of appliances for the reduction of smoke both in manufacturing and domestic fires.

The idea entertained by the promoters of the Exhibition has been that, in order to effect a reduction in the quantity of smoke poured out of chimneys of different kinds in large towns, it was first necessary to convince people that appliances exist which will tend to this result, and it was therefore determined to invite an exhibition of smokeless fuels, and apparatus for burning them, as well as of appliances for lessening the amount of smoke given off by bituminous coal. The call has been very readily responded to, and the catalogue shows a list of over 230 exhibitors.

Tests are being made by experts of the performances of the different apparatus, which, in the case of the domestic grates, &c., are carried out in specially constructed rooms ; the fumes passing up the chimneys being carefully examined to determine the quantities of carbon (other than carbonic acid) and other unconsumed matter passing away from the fire ; the consumption of fuel and the temperatures maintained being also carefully noted. A jury has been appointed to award prizes, medals, &c. to those appliances which they consider best adapted to fulfil the purposes in view.

The Exhibition is naturally divided into two great divisions : appliances for trade purposes, and those for domestic purposes. In the first division the economic use of gas instead of solid fuel is illustrated in a small kiln for burning pottery and glass, and its use, instead of steam, is shown in several different kinds of gas-engines. The means of producing steam, however, occupies the principal place in this division. Several mechanical stokers and other appliances for firing boilers, so as to produce no visible smoke, are shown, and those which are at work demonstrate that—at least after steam has once been got up—it is easy to raise any quantity of steam without the production of smoke at the top of the chimney. Moreover, as these appliances are stated, on apparently good authority, to effect an economy in the expense of raising steam, it is to be hoped that their adoption is rapidly becoming general.

It is with the second division, however, that most individuals are more particularly interested, and it is from fires of this kind that the bulk of the smoke is produced, at all events in the west end of London.

Domestic fires, again, may be divided into two classes, those for cooking and those for warming rooms. It is with the latter that we propose to deal in this article. And first we will consider what it is that we want in our living rooms. We are strongly of the same opinion as Sir F. Bramwell, that we must have an "open, pokeable, companionable fire."

We believe that the value of an open fire for warming living rooms cannot be too strongly insisted on ; Dr. C. W. Siemens has lately pointed out why a room in which the air is comparatively cool, and the walls, furniture, &c., are warmed by rays from the fire, as is the case when an open fire is used, is so much more pleasant and healthy than one in which the air is warmed by contact with hot surfaces of the stove or heating apparatus, and the walls, furniture, &c., are at a lower temperature, and we believe it is to the use of open fireplaces that the general freshness of complexion of the inhabitants of these islands, and the absence of the use of spectacles among the young, are in a very large measure to be attributed.

One disadvantage in open fires, which has been much dwelt upon—the waste of fuel—is we believe considerably exaggerated. Doubtless a small proportion of the coal used in an open fire-place would be sufficient to maintain the temperature of a room if a close stove were used. But is the rest so entirely wasted as some would have us believe? The greater part of the heat, as they say, "goes up the chimney." Is it therefore wasted? We think not. It performs work in ventilating the room, and it is at least doubtful whether in an ordinary dwelling room the same quantity of vitiated air could be removed (and therefore the same quantity of fresh air be introduced) as cheaply and conveniently by any other means ; at all events, the so-called "waste heat" could not be made use of to any large extent as radiant heat, and open grates are shown in the exhibition in which a part is utilised in warming air for admission to the room, or heating water-pipes, &c.

The problem of how to have an open fire without smoke, or with considerably less smoke than we have at present, is one towards the solution of which we hope this exhibition will give valuable assistance. Fires are shown in which gas, coke, these two together, anthracite, or Welsh coal, and bituminous coal, respectively are the fuel. Several different kinds, both of gas stoves and open gas fires are shown. There seems to be no novelty in any of them, and we believe that they are generally so well known as to need no description here ; they have the merit of being extremely handy and cleanly ; they are not

"pokeable" nor very "companionable," and we are afraid that the very unpleasant fumes of burnt gas—caused, we suppose, by so many of the gas fires shown not being provided with flues—which pervade this portion of the exhibition when the gas apparatus is shown, must prejudice visitors very much against the use of these very valuable appliances.

Dr. Siemens' coke and gas fire, which has been so recently described in these columns, is shown by several exhibitors. It is necessarily free from visible smoke, and almost so from dirt and dust, and it is very manageable; that is to say, by altering the supply of gas the heat may be easily and quickly regulated. How far it is free from the noxious fumes which usually seem to accompany the combustion of coke or smokeless coal in a room cannot be judged in the exhibition.

The same remark applies to the many grates shown for burning anthracite and smokeless coal. Many of these look very nice; a bright, hot fire is obtained which almost comes up to Sir F. Bramwell's standard. It seems to us, however, that anthracite fires are not very manageable; the fire must burn at one rate, and the fuel must be supplied accordingly; you cannot quickly get up a hotter fire by the use of a poker, as is so easy with bituminous coal, nor can you so easily reduce the fierceness of the fire as can be done with so many grates in which bituminous coal is burnt. The absence of smoke is, however, a very great advantage, and unless this can be attained, or nearly so, with bituminous coal, we ought to be prepared to give up the luxury of its use.

There are two methods by which it appears possible to reduce very considerably, if not to prevent entirely, the production of smoke in domestic grates. One is to supply the coal to the fire in such a way that the smoke and gases escaping from the portion last supplied may pass through the live coals and so be consumed; the other is to introduce a draught of hot air at the top of the fire, there to meet and consume the smoke and gases given off by the newly-supplied coal.

Dr. Arnott's stove is a type of the first method. In it the coal for the day's use is put into a box underneath the grate, which latter has no bottom; by means of a lever the bottom of the box is raised, and fresh coal pushed into the fire as required. There is thus no escape for the gases given off by the fresh coal but through the hot part of the fire. These stoves, however, have never come into very common use. We believe that they are not found to be pleasant in a room, and that the reason of this is that although little or no smoke is given off, there is not sufficient air admitted to the fire to burn the carbonic oxide produced, the grate being closed at the bottom, sides, and back, and the front being narrow. No stove of exactly this description is shown in the exhibition, though there are several in which the principle for getting rid of the smoke is adopted. Messrs. Brown and Green, of Luton, Bedfordshire, show a register stove for bituminous coal (and a kitchen range on the same principle), in which the coal is supplied to the fire by a kind of trough or shallow hopper placed in front of the bottom bars, from which the coal can be pushed into the fire, to facilitate which operation the bottom of the grate is made to slope upwards towards the back. Mr. Engert places a box for the fuel at the back of the grate. This box has a sliding back worked by a screw underneath, by which means the fuel is pushed forward into the fire as required. He thus secures a wide front for his fire, and less depth of live coal than in Dr. Arnott's stove. By means of a kind of baffle plate hung at the back of the grate the gases issuing from the coal-box are deflected into the fire instead of going up the chimney. The coal-box can be recharged if necessary without actually putting out the fire. It appears possible to adopt this arrangement to an existing grate of ordinary form at comparatively small expense.

Messrs. Martin and Co. seek to attain the same object by having movable cheeks to the grate, which work horizontally inwards by levers. The coal being put on at the sides is gradually pushed in by this means towards the more active part of the fire. The back plate of the grate has a space behind, and is perforated in the centre so that heated air is thus admitted at the centre of the back of the fire to assist in the combustion.

Thompson's patent consists in having the front of the grate made so as to slide upwards a few inches. The bottom of the grate consists of a plate of iron and is fixed. For the purpose of putting on fresh coals a tool is used consisting of a sheet of iron of the same shape and size as the bottom of the grate, hinged to a rod somewhat like an ordinary poker at a distance from its end equal to the height from the hearthstone to which the front of the grate rises. The iron plate being pushed in between the coals and the bottom of the grate with the rod in an inclined position, the handle of the latter is pushed forwards, the whole body of the fire and the front bars are thus lifted a few inches, and the fresh coal is put in between the two plates; the implement being withdrawn, the front of the grate falls again to its proper place, and the live coals come in immediate contact with the fresh coal underneath it. The back of the grate is perforated, so as to admit heated air to the fire. This arrangement could probably be adapted to many existing grates, without very great expense.

Saxon Snell's patent consists of a cylindrical grate mounted on a very strong horizontal pivot at the back, and in the line of its axis. At opposite sides of the perpihery are two grated doors which are hinged to the back edge of the grate; the uppermost one is opened, and lies back against the chimney-back. When fresh coal has been put on, the upper door is shut and fastened, and the grate turned half round, so as to bring the other door to the top, and the live coal above the fresh coal. We believe that the combustion in this grate would be improved by some holes in the back through which heated air might be admitted near the top of the fire, and these could easily be made.

The grate shown by E. R. Hollands, of Newington Green, is rather more complicated than some of those which we have described; but its performance appears to be good. A movable set of bars fit in between the fixed bottom bars of the grate; and the lower part of the front is made to open forwards and downwards. A neatly-devised motion worked by a lever at the side of the fire-place raises the movable bottom bars, and with them the fire, and opens the lower part of the front, the fresh coal being then placed between the two sets of bars, the return of the lever to its place causes the front of the grate to shut and the movable bottom bars first to recede through the back, and then, having fallen below the level of the fixed bars, to come forward and up again into their original place. The back of this grate is hollow and is pierced with small holes at about the level of the top of the fire. The combustion effected by the hot air passing through these holes is clearly visible.

In the slow combustion grate of Fredk. Edwards and Son, which is shown in action, the "Arnott" principle is made use of, but instead of the bottom being movable, a counterbalanced shutter works vertically in front of the grate, which is very deep. The latter being filled and the fire lighted from the top, the shutter is adjusted from time to time, so as to obtain the requisite amount of fire, by exposing more or less of the front of the grate.

Messrs. Musgrave and Co., of Belfast, besides several of their well-known "slow-combustion" stoves, show a fire place which they call the "Ulster." In this the coal is fed into the back of the fire from a hopper placed behind the chimney-back, in which is a close-fitting door for closing the opening through which the hopper is filled. The coal is pushed forward into the fire by an arrange-

ment worked by a lever at the side of the grate. The coal is thus coked before it comes into the fire, the only escape for the gases being through the glowing coals. Somewhat similar in some respects to this is the "Wonderful" grate of Archibald Smith and Stevens. In this the fireplace is closed by an iron plate, in which are three rectangular openings one above the other. To the lowest, which is about the floor-level, the grate is fitted; this, made of a basket shape, can be mounted on a pivot in the plane of the plate, so that more or less of the grate may project into the room. Between the top hole in the plate and the upper half of the bottom hole is a flat-sided tube, which curves backwards into the fireplace. This is the hopper for the fuel; it is shut at the top by a close-fitting door, and the curved shape causes the fuel to descend easily into the fire. The centre opening of the plate is provided with a register door, and in some instances is covered with a hood. The arrangement of the hopper causes the gases evolved by the fresh coal to pass through more or less of the live coal before they can escape, and by closing the centre opening the whole draught is made to go down through the lower half of the bottom opening, causing a rapid combustion. Four of these grates are shown in action, with different sorts of fuel. They seem to require little or no attention for hours together, as the feeding arrangement appears to act well.

A grate of the pattern which has been in use in barracks for the last two or three and twenty years is exhibited. This grate was devised by Capt. Douglas Galton. It consists of a cast-iron stove, entirely open in front, which is fitted to the chimney opening, leaving a considerable space between the stove and the brickwork at the back. Into this space air is admitted from the outside of the building. From the top of the fireplace recess proceed two flues; one, the ordinary chimney-flue, receives the covered smoke pipe from the stove, the other delivers into the room through a lowered opening a little below the ceiling level, the air which has been warmed in the chamber behind the stove, the back of which has iron plates projecting from it, so as to increase the heating surface. The cast-iron stove is entirely lined with fire-brick, in the manner to be described, so that the air does not get unduly heated.

A little above the level of the fire the stove is gathered in towards the room so as to form a kind of baffle. The actual grate is formed as follows:—two fire lumps are placed on the hearthstone with a space between them of six inches or so, over which is a cast iron grid; the cheeks and back, all of fire-brick, rest on these first lumps; another lump of fire-brick of curved section underneath fits on the top of the back and cheeks, and underneath the gathered in part of the stove. Between the back fire-lump and the iron back is a space, and there is also a small opening between the back piece and the top piece, through which air heated at the back plays on the top of the fire and helps to consume the smoke. This stove is, we understand, found to be very economical in action, and is very highly spoken of in the work of the late General Morin on Heating and Ventilating. It will not, however, be tested in this Exhibition, as it is not shown in competition.

Messrs. Barnard and Bishop, of Norwich, have pushed the "baffle" principle still farther in their "glow" stove. Instead of coming only about half over the fire as in the Galton grate, the baffle consists of a fire-brick which projects nearly to the plane of the front bars of the grate, and slopes down slightly towards the front. The bottom of the grate, which slopes upwards, and the back which slopes backwards, are made of fire-brick in one piece, the front bars being the only ironwork about the grate. A flue which goes up behind the back opens to the fire just under the back edge of the baffle, the space under which and over the fire is thus converted into a combustion chamber in which the gases from the coals are burnt, and as these have to pass over the front of the baffle before going up the chimney the radiant heat from them comes into the room.

Several grates are shown by different makers, in which the combustion of the gases is accomplished with a down draught. But in these cases the radiant heat evolved in the process cannot come into the room directly, as it does in the case of the "glow," it is therefore lost in the case of a grate set in a fireplace unless it be utilised to heat air which is admitted to the room. A small open-fronted stove on this principle is shown by Mr. T. E. Parker, in which the combustion appears to be very perfect. The internal arrangement is too complicated to describe without a drawing, but the essential point is that the draught from the fire is led away at the back of the bottom of the grate into a flue lined with fire-brick, where it meets a draught of fresh air which has been warmed by contact with the underside of a ribbed plate which forms the bottom of the grate.

Several examples of grates with down draught and chambers for heating air to be admitted to the room are to be found in the exhibition, as well as some in which the heating chamber or flues are applied to grates with ordinary up-draught. The warm air inlets are usually placed close to the fire, which is, in our opinion, a mistake, as the general circulation of air in the room is not so much promoted by this arrangement as when the inlets are at some distance from the fire; there are, however, difficulties in so placing them in an ordinary living-room.

A stove of a peculiar, and we believe quite novel, construction is shown by Mr. James B. Petter. The recess of the fireplace is lined with white marble; in each jamb is a circular hole from which a pipe leads round to the chimney. The fire-box is mounted on legs with castors, so that it can easily be rolled in or out of the fireplace, and is provided with horizontal exit flue pipes at the sides which are connected with the openings in the jambs by sliding pieces. A vertical section of the fire-box from front to back is of open spiral or Nautilus form. The box is made of iron and lined with fire-brick from the lip to the top of the back, there being no bars either in the front or bottom. The coal is put on thinly at the lip, and gradually pushed back, as in stoking a steam-boiler. A rather sharp draught is produced over the red hot fuel towards the back, and the convolution of the box appears to form a kind of combustion chamber. It would seem that the difficulty of lighting the fire would be considerable, but it appears to work well.

We have endeavoured in this notice to give a slight sketch of such grates, &c., as present any salient features. We may have overlooked some which were deserving of notice, but we would earnestly recommend our readers to pay a visit to this very interesting exhibition, and to form their own opinion of the merits of the various apparatus shown.

We may mention that representatives have been accredited to the Exhibition by the Governments of Austria-Hungary, France, Prussia, Saxony, and the United States; and that the interest taken in it has encouraged the Committee to entertain the idea of holding an International Exhibition in about three years' time of such further developments of smoke-abating appliances as may be produced either in this or other countries during the interval.

THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS

PART I.—*Local Action*

AMONG the important discoveries of late years, few have claimed so much attention, or have been so full of promise for practical use, as the accumulator of